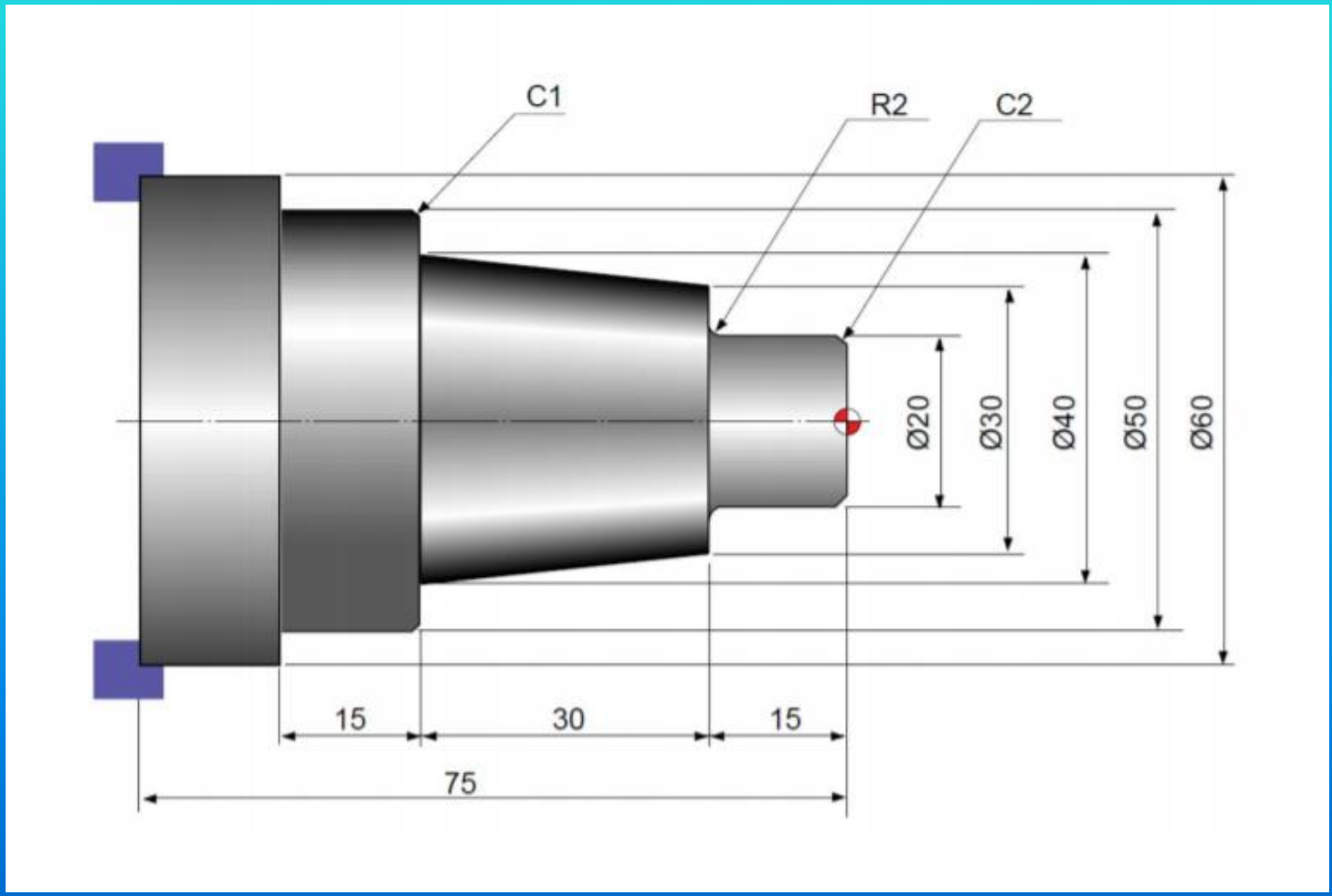
MANUFACTURING TECHNOLOGY:
Project Report

Group 7:

- Clint Antony (131501008)
- Gumpula Aravind (131501012)
- M.Hari Chaitanya (131501017)
- Mohammed Iqbal (131501019)

Our Project:



Raw Material:
D2 Steel

- **D2 steel** is an air hardening, high-carbon, high-chromium tool steel.
- It has high wear and abrasion resistant properties.
- D2 steel's high chromium content gives it mild corrosion resisting properties in the hardened condition.

Composition of D2 Steel

- 1.5% C,
- 11.0–13.0% Cr;
- Additionally 0.45% Mn, 0.030% P, 0.030% S, 1.0% V, 0.9% Mo, 0.30% Si

Applications:

- Rolls, punches, dies for blanking, forming, trimming, and thread rolling, shear knives, food-processing knives etc..

Tool Used:
PCBN

- Polycrystalline Cubic Boron Nitride
- Close tolerance, excellent surface finish, and productivity.

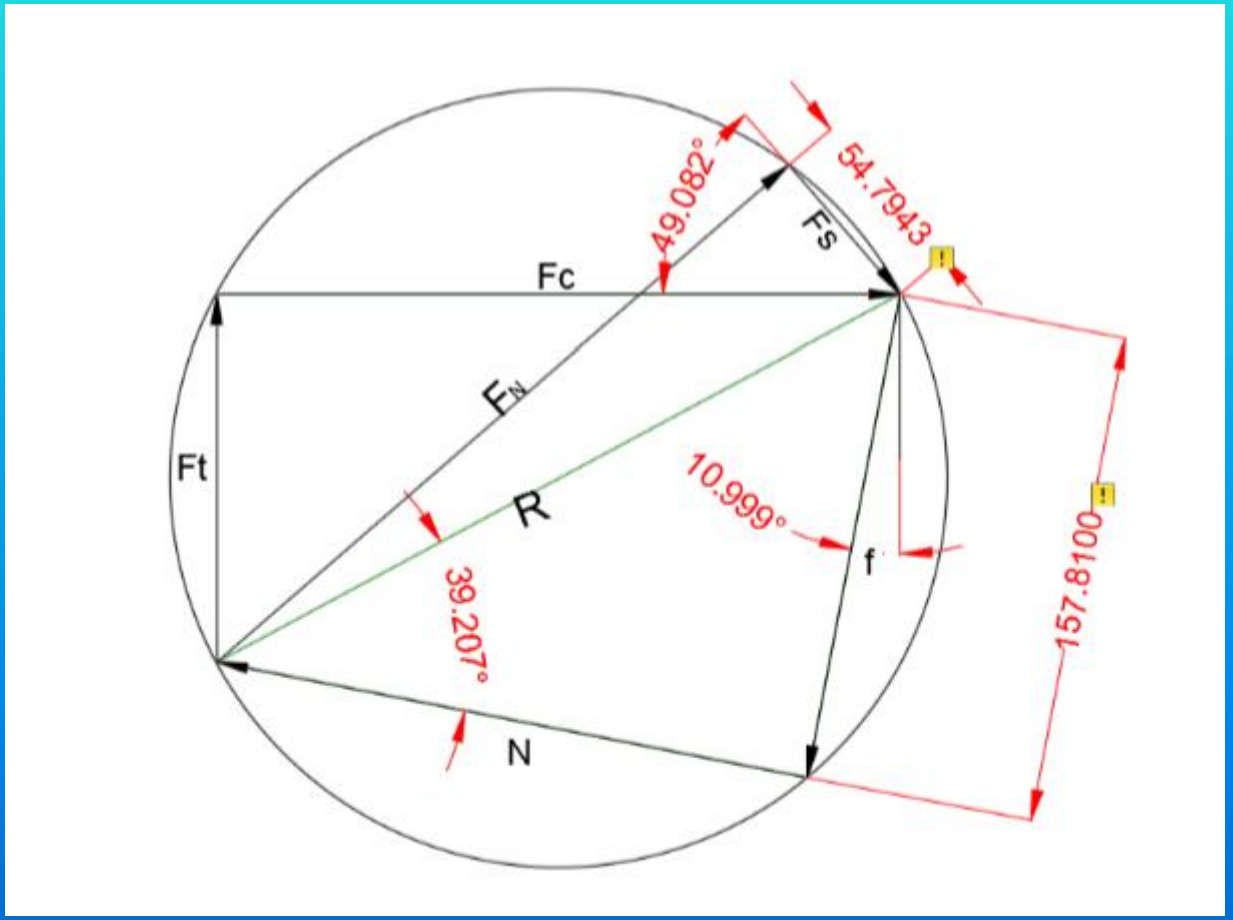
Given Parameters

- Cutting force (F_c) = 220N
- Thrust force = 118N
- Rotational speed = 2000 rpm
- Feed (f) = 0.18 mm/rev
- Depth of cut = 0.24 mm
- Rake angle (α) = 11 deg
- Chip thickness before cut (t_o) = 0.24 mm
- Chip thickness after cut (t_c) = 0.25 mm

Assumed Parameters:

- We have assumed that the turning process starts when the cylinder is made into the dimension of height 75 mm and diameter 60 mm and hence time and energy before the specimen creation is not calculated (it can be done by the same approach).
- The tool return velocity is 3 cm/sec.
- Time for tapering and filleting is avoided in the calculations.

Merchant Circle Diagram



Formulas used:

$$\tan\theta = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

where

- r = *chip thickness ratio or cutting ratio*;
- α = Rake angle
- θ = *Shear angle*

SOLUTION OF MERCHANT'S CIRCLE

Knowing F_c, F_t, α and ϕ, all other component forces can be calculated as:

$$F = F_c \sin\alpha + F_t \cos\alpha$$

$$N = F_c \cos\alpha - F_t \sin\alpha$$

The coefficient of friction will be then given as :

$$\mu = \frac{F}{N} = \frac{F_c \tan\alpha + F_t}{F_c - F_t \tan\alpha}$$

$$\lambda = \tan^{-1}\mu$$

On Shear plane,

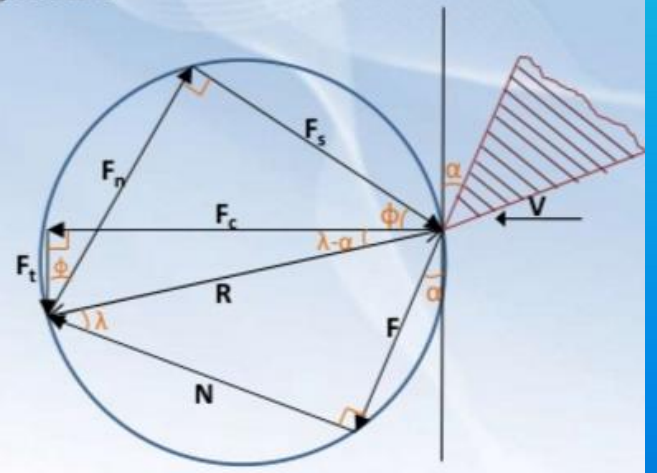
$$F_s = F_c \cos\phi - F_t \sin\phi$$

$$F_n = F_c \sin\phi + F_t \cos\phi$$

Now,

$$F_t = F_n \cos\phi - F_s \sin\phi$$

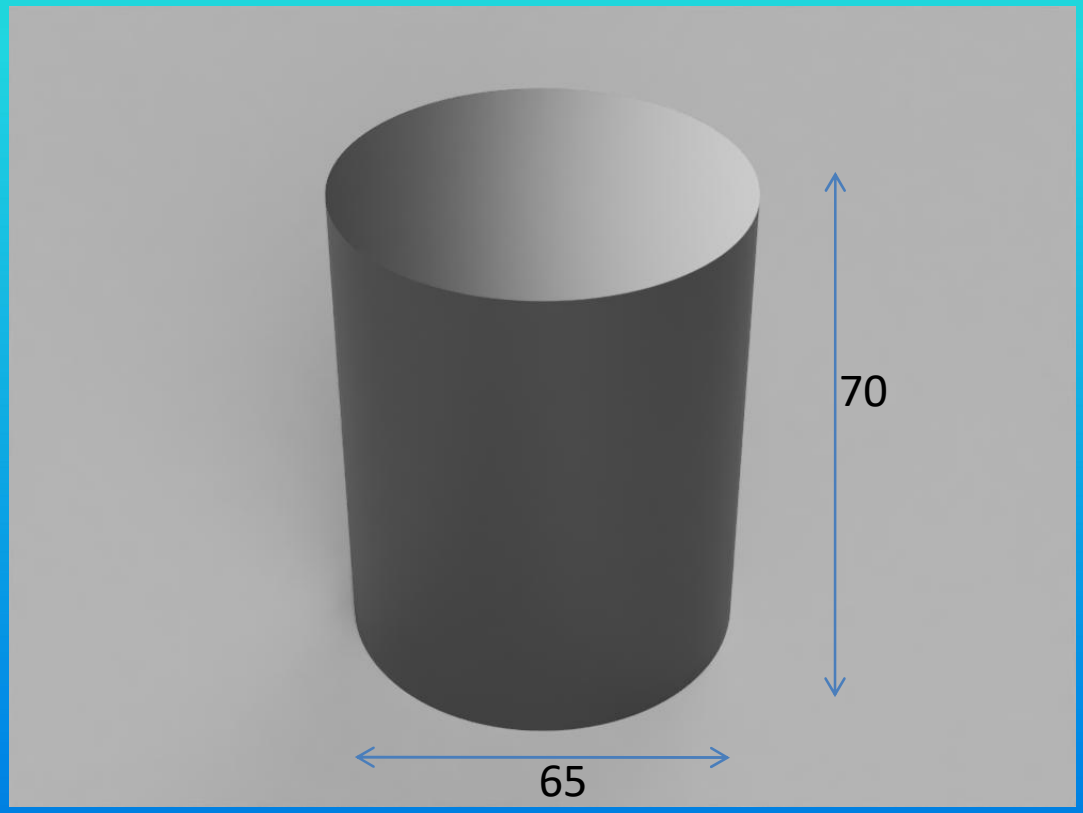
$$F_c = F_n \sin\phi + F_s \cos\phi$$



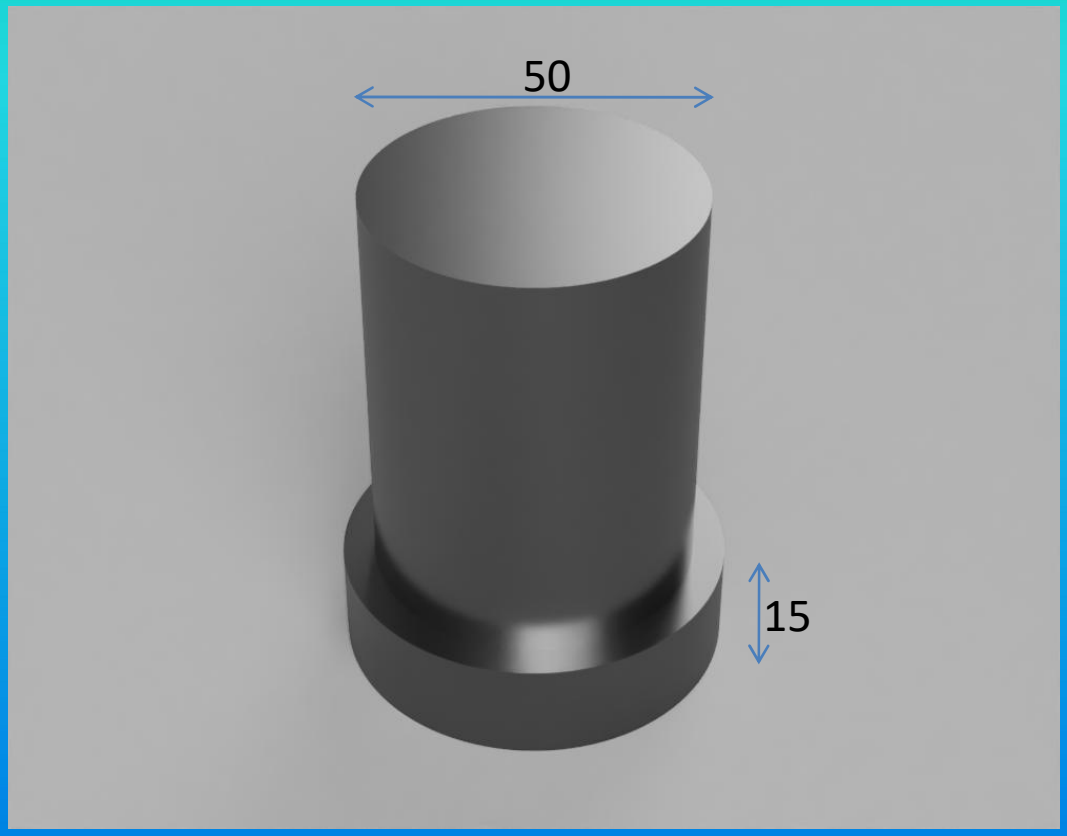
Quantities obtained from Merchant Circle

- Φ = Shear angle = 49.082 deg
- Frictional force = 157.81 N
- Shear force = 54.928 N

Step 1:



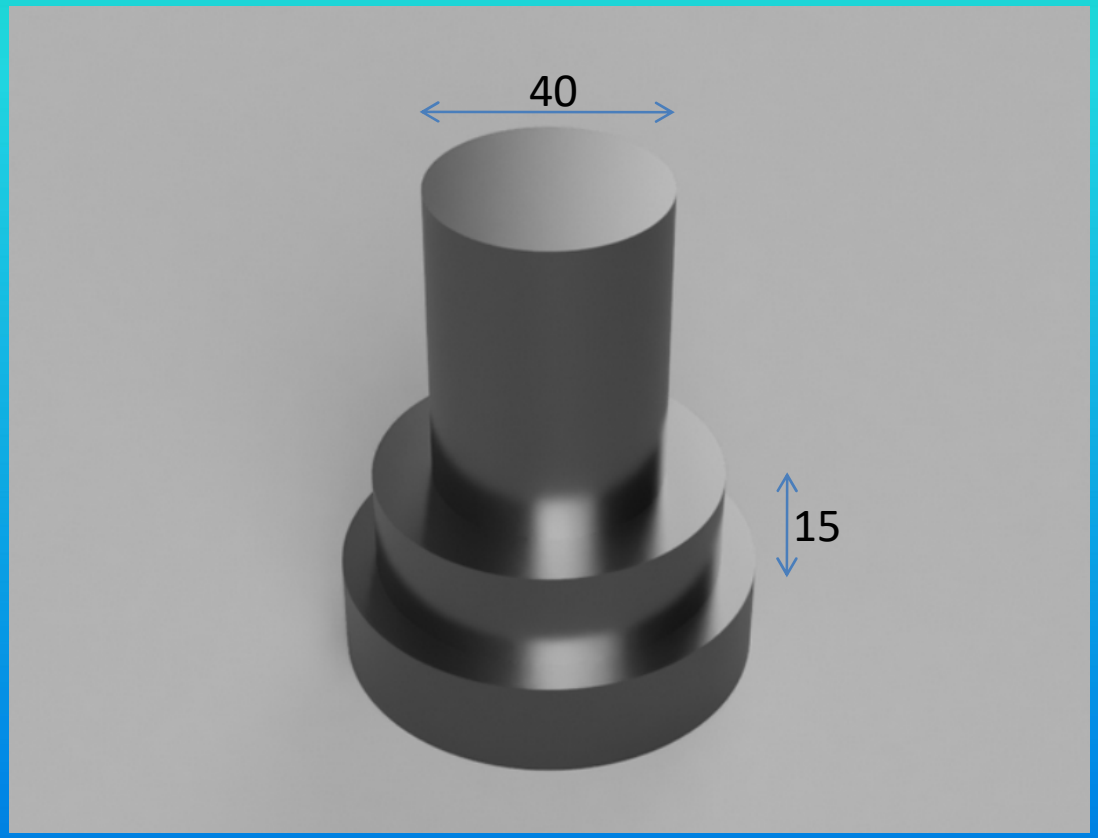
Step 2:



Number of steps = 22
Cutting Energy = 278.57 kJ

Total time = 3.6666 min
Friction Energy = 208.15 kJ

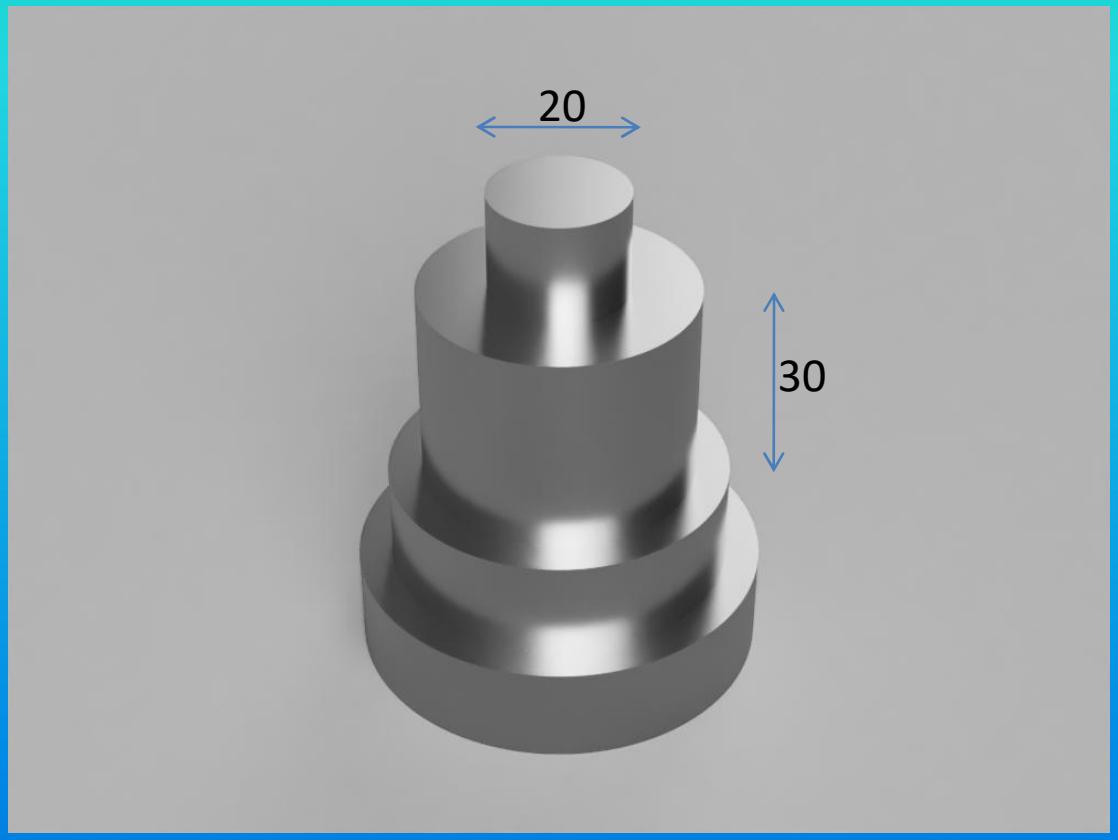
Step 3:



Number of steps = 21
Cutting Energy = 170.92 kJ

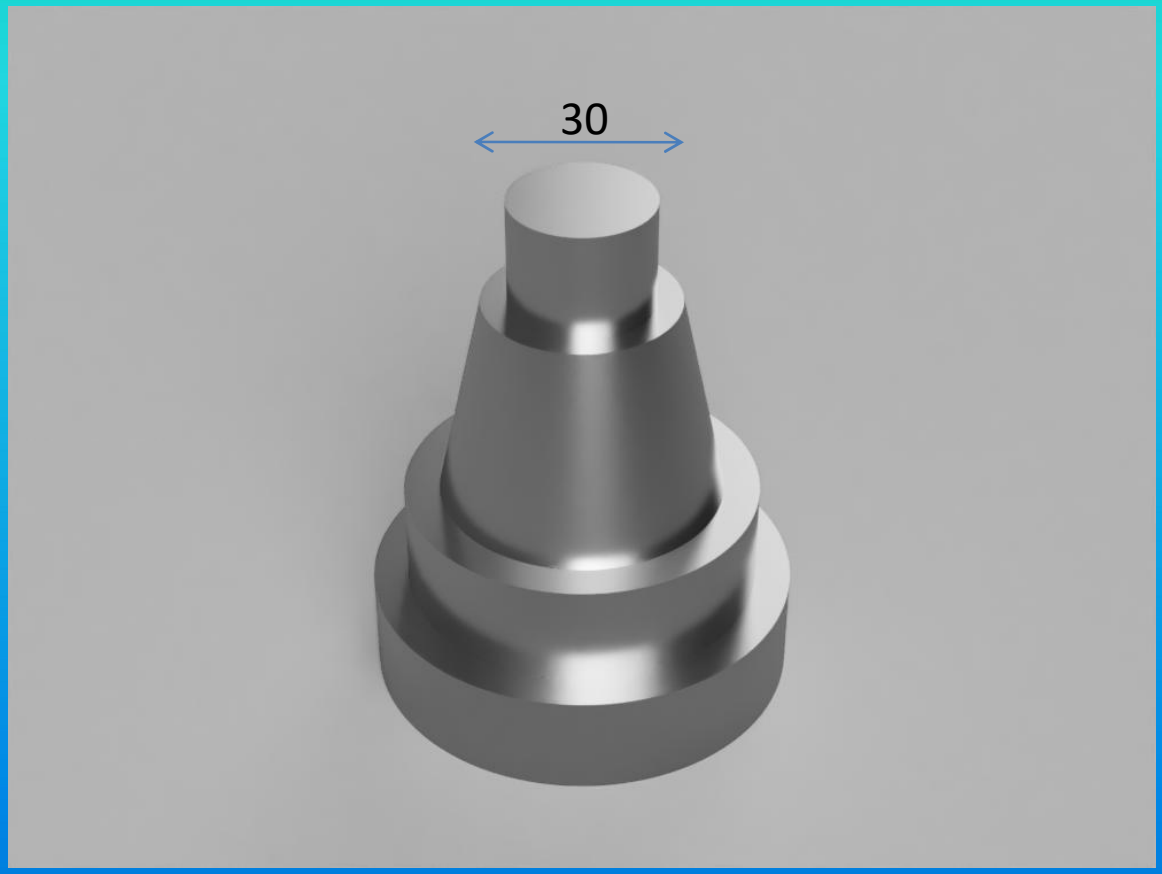
Total time = 2.75 min
Friction Energy = 127.71 kJ

Step 4:

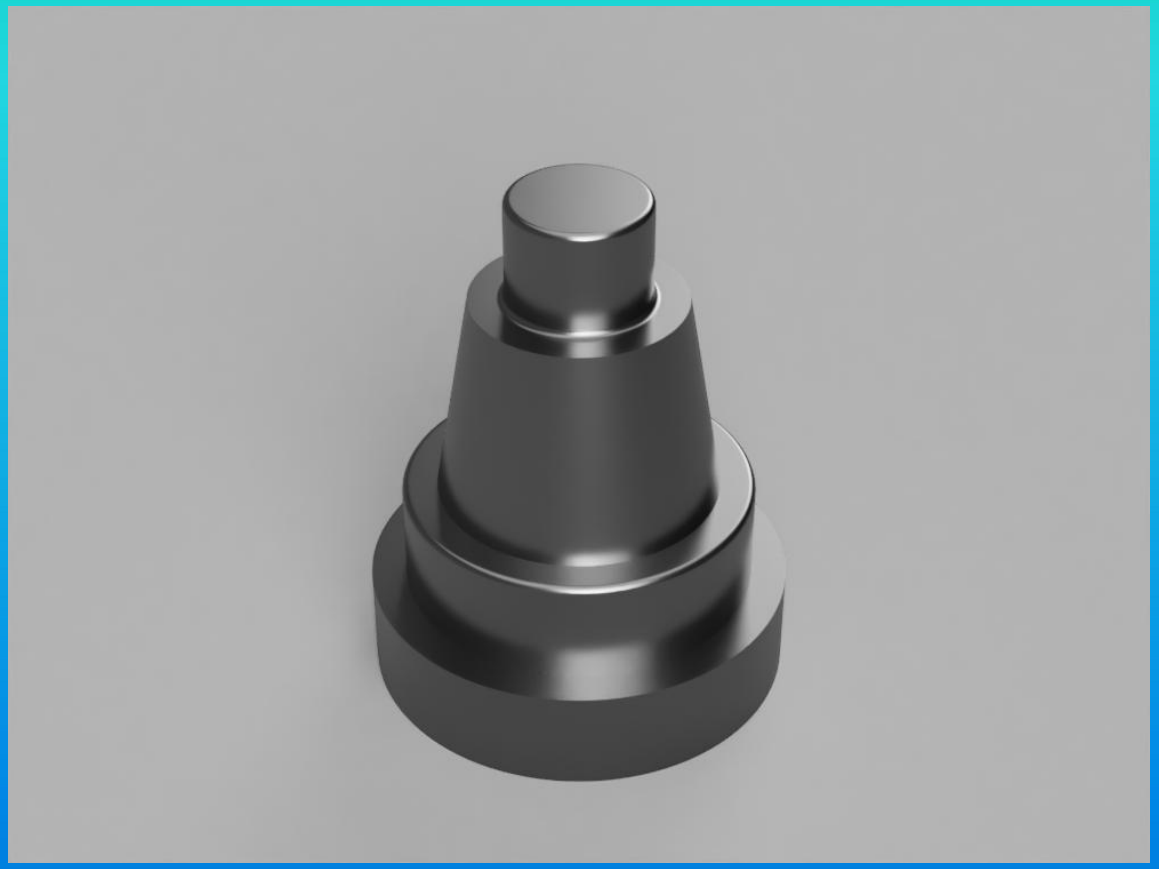


Number of steps = 42 Total time =1.75 min
Cutting Energy = 71.8 kJ Friction Energy = 53.65 kJ

Step 5 (Tapering):



Step 6 (Filleting):



FINAL PRODUCT !!!

Deriving Other Quantities

- Time = $\pi D L / (f V_c)$
- Cutting energy = $F_c \; V_c \; t$

  (F_c = Cutting force, V_c= Velocity of cutting)
- $Vc = \pi D N$
- Friction energy = F V t

  (F = Friction force, V = Chip velocity)
- $t_o / t_c = V_c / V$
- Total Power = $F_c * V_c$

Total Values:

- Time taken for turning = 15.80 min
- Addl. time = 1.575 min
- Total time = 17.37 min
- Total Cutting energy = 1010.35 kJ
- Total Friction energy = 761.37 kJ
- Power required (cutting) = 1.06 kW